A Study on The Comparison of AHP And Fuzzy AHP Evaluations of Private Technical Institutions in India

DEBMALLYA CHATTERJEE
Research-Scholer,
Department of Applied Mathematics,
Indian School of Mines,
Dhanbad, Jharkhand, India

BANI MUKHERJEE
Professor,
Department of Applied Mathematics,
Indian School of Mines,
Dhanbad, Jharkhand, India

Abstract - **The numbers of private technical institutions in India are increasing rapidly in the recent decade. Today there are thousands of private self-financed technical institutions most of which are compromising with their quality of education. Analytical hierarchy process (AHP) and its fuzzy extension (FAHP) are two of the efficient tools by which one can evaluate such institutions. There are ample numbers of studies in literature that discussed the efficiencies of the AHP and FAHP separately. This present piece of work makes an attempt to study and quantify the difference, if any in the applications of AHP and FAHP on the evaluation of self-financed private technical institutions in India.**

Key words: Analytical hierarchy process, Fuzzy analytical hierarchy process, technical institutions, comparative study.

I. INTRODUCTION:

Technical education in India plays a vital role in the development of any nation. It not only includes engineering education but also contributes in the developmental activities of the nation. Since the era of liberalization, globalization and privatization, there has been a significant changein the field of technical education in India [12]. The growth is significant and can be seen from the Figure 1.

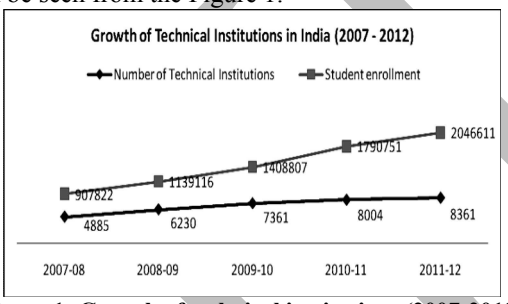


Figure 1: Growth of technical institutions (2007-2012)
Source: Report of the working group 2011-12, Dept. of Higher Education, Ministry of Human Resource Development, India.

Out of numerous of private self-financing technical institutions that have emerged, a few are offering quality education but many of them are compromising with the quality. The stakeholders are confused in selecting a quality institution for their career development and prosperity. Because of low quality institutions the graduated student has become a suspect. This phenomenon raises the important question: how to select a quality institution?
The importance of using a tool like AHP or FAHP in multi criteria decision making like evaluation of technical institutions in India has been the illustrated in many studies done by the researchers across different field where they talked about capturing tangible and intangible factors as well ([2]; [5]; [7]; [8]; [9]; [10]; [11]; [13]).

Interestinglythe researchers in most of their study involving FAHP opinioned that embedding fuzzy mathematics with the classical AHP helped capture the vagueness of human decision making and provided better precision ([1]; [6]; [14]). However no existing study illustrated the difference by quantifying it through the application of AHP and FAHP on the same problem.

The following sections of this paper makes an attempt to demonstrate the detailed comparison between the results i.e. convergence and non-convergence in terms of the factor weights, sub factor weights and alternative scores obtained in the evaluation of private self-financed technical institutions using AHP and FAHP respectively. An attempt is also made to find the statistical significance of the correlation between the results obtained using the two different methods.

II. METHODOLOGY

A. Selection of respondents for the study

The analytical hierarchy process (AHP) and its fuzzy extension (FAHP) are both capable of handling a mixture of subjective and objective feedbacks and because of this character requires consistent inputs for efficacy. This character of both AHP and FAHP invites 'expert opinion' for consistent evaluations of the factor weight.

In this study twelve experts were selected from academia having more than fifteen years' experience in the field of engineering education and were associated with all the three technical institutions of Durgapur for some time in their career. Mostly the

respondents were the Professors, Departmental Heads, Deans and Deputy Directors who have worked in these institutes for some time in their career within the last ten years.

The experts were requested to do pair wise comparisons among factors, sub factors and alternative institutions and identify the level of importance of one over the other. To do that a set of questionnaires were provided to the experts.

B. Identification of factors and sub factors for the evaluation

Besides the identification of experts for the study the identification of the factors and sub factors is also a critical task for the success of both AHP and FAHP models. The factors and sub factors in the performance evaluation of a self-financing technical institution (under AICTE) in India is available in the format mentioned by National Board of accreditation (http://www.nba-india.org) under the banner of All India Council for Technical education (AICTE). Since its inception in 1945, AICTE is in the process of improving the governance and after a lot of permutations and combinations structured the set of criteria for the evaluation of a technical institution. Since this set of factors and sub factors are well established and are evaluated in the NBA accreditation process in India, the researcher in the present study relied on the same set of factors and sub factors with some modification / adjustment suitable for the study restricted to private self-financed technical institutions in India. The expert opinions were sought to shape the final selection or alteration of the factors and sub factors for the study. The factors and corresponding sub factors identified for the present study can be found in Table 1.

Table 1: Factors and sub factors selected in the study

Factors	Sub Factors
Campus Infrastructure	Hostel, Transport/ canteen, Power backup, Security
Faculty	Teacher/ Student ratio, Qualification/ Experience of Faculty, Faculty retention
Student	Admission, Academic Result, Placement
Academic Ambience	Classroom, Laboratory, Library
Teaching Learning Process	Syllabus coverage, Tutorial/ remedial class, Use of Advance Teaching Aid
Supplementary Process	Alumni, Co-curricular activity, Cultural activity, seminar/ workshop

C. Identification of alternatives in the study

This study is aimed to evaluate the private self-financing technical institutions in India and hence a sample of three such institutions from Durgapur, West Bengal is taken for the study based on convenience.

Eight technical Institutions are functioning in the sub division of Durgapur, West Bengal offering B.Tech in different specializations. Out of these eight, two are government institutions and three private self-financed institutes emerged very recently and still fighting to get students. The remaining three self-financed technical institutions are selected as alternatives in this study.

This reason behind shortlisting these institutions is considered because all the three select institutions were established on or before 2002, i.e. they have been providing engineering education for a decade or more and around two thousand students graduated from each of those institutions. Moreover all the three shortlisted institutes are within ten kilometers from the nearest railway station and also admit students through the common West Bengal Joint Entrance Examination (WBJEE).

The year of establishment is taken as main factor for short listing the alternatives as it indicates that all of them are in the growth phase and they survived infancy. Moreover, the government institutions within the sub division are not selected because they do have a completely different pattern of funding and previous studies criticized the comparison of institutes having significant variation in funding. The names of the institutions are disguised as Alternative 1, Alternative 2 and Alternative 3 for the smooth conduct of the study.

D. Construction of the detail hierarchy of the problem

The design of the problem hierarchy is an essential step in common to both AHP and FAHP methods. This hierarchy help the researcher understand the problem and the associated flow. The hierarchy in the problem of evaluating technical institutes is structured keeping the objective at the top (performance evaluation of self-financed technical institutions) through the intermediate levels (main and sub-factors on which subsequent levels depend) to the bottom level (the list of three private self-financed technical institutions as alternatives).

Figure 2 describes the hierarchy of this problem in which the objective is at the extreme left followed by the factors and then the sub factors of evaluation. Finally the alternatives to be evaluated are at the

extreme right in the hierarchy. Instead of a top to bottom flow, the present hierarchy has a left to right flow.

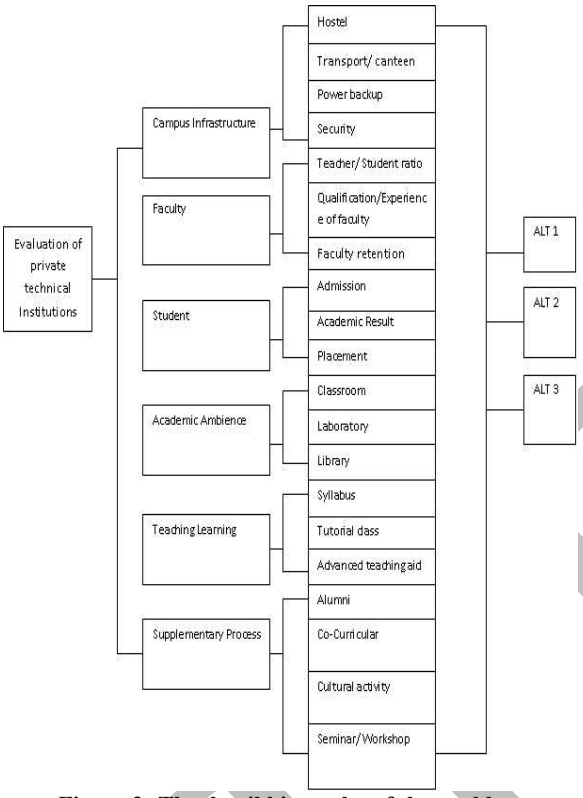


Figure 2: The detail hierarchy of the problem

E. Generation of factors weights and score for alternatives

Once the hierarchy is established, the next step is to do pair wise comparisons between the factors and between the sub-factors within each factor considered in the study. This pair wise comparison is done based on the linguistic preference scale which can be non-fuzzy or fuzzy depending on the model of choice. These steps of computation vary significantly across classical AHP and fuzzy AHP and can be seen from the studies by Chatterjee and Mukherjee ([3];[4]).

III. RESULTS AND DISCUSSION

A. Comparison between factor weights

To understand the difference or similarity between the results obtained using AHP and FAHP methods respectively, let us start first with the factor weights. Figure 3 illustrates the weights of the factors with respect to the two methods considered in the study. From the figure one can see that the weights of the factors 'campus infrastructure' and 'teaching learning process' are almost the same across the two methods with slight differences in the other factors considered in the present study. Interestingly the order of importance of the factors varies across the two methods slightly. Where 'faculty' got the highest weight in AHP, 'campus infrastructure' got the highest with respect to FAHP. Similar situation happen in case of 'academic ambience' and 'teaching learning process'.

However from Table 2 (SPSS output) it can be seen that there exists a significant correlation with $\alpha = 0.016$ between the weights of the factors corresponding to AHP and FAHP respectively. Though there are some differences in terms of weights of the factors across the results from the two methods discussed, but the result of Table 2 indicates that the difference is not significant.

Figure 3: Comparison of factor weights

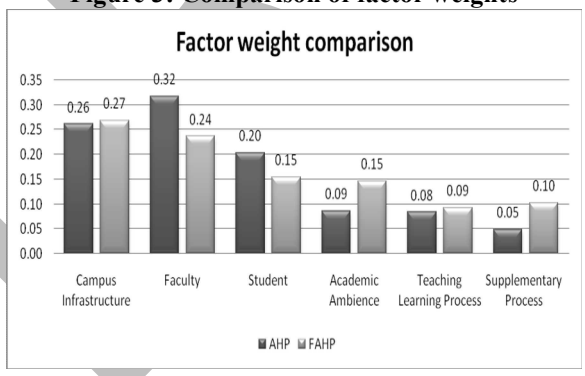


Table 2: Correlation between the factor weights

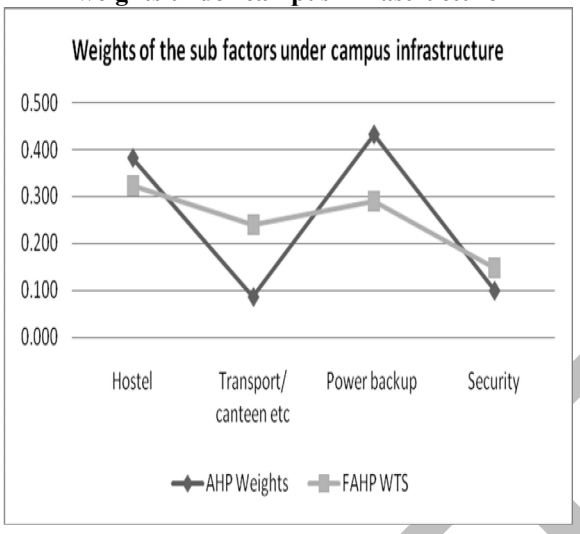
		AHP Factor weight	FAHP Factor weight
AHP Factor weight	Pearson Correlation	1	.894*
	Sig. (2-tailed)		.016
	N	6	6
FAHP Factor weight	Pearson Correlation	.894*	1
	Sig. (2-tailed)	.016	
	N	6	6
*. Correlation is significant at the 0.05 level (2-tailed).			

B. Comparison between the sub factor weights

Once the weights of the factors got compared it is important to see the comparison between the AHP sub factor weights and FAHP sub factor weights under each factor. From the Figure 4 one can witness that the trend is almost the same for the sub factors under 'campus infrastructure' in both AHP and FAHP results. However variations of weights are

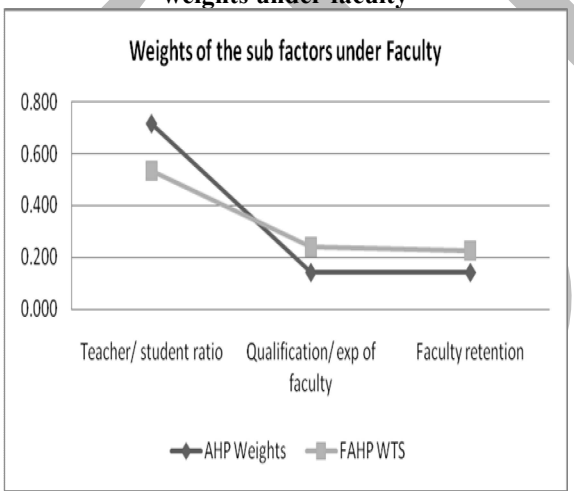
more in AHP in comparison to FAHP. In terms of importance also 'hostel' and 'power backup' are the two top sub factors that evolve in both models.

Figure 4: Comparing between the sub factor weights under campus infrastructure



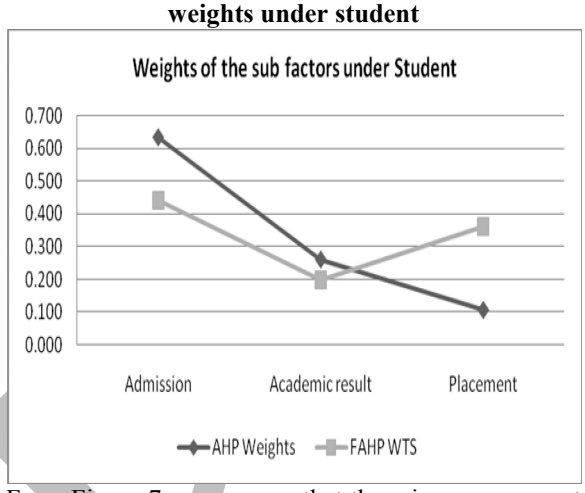
Under the factor 'faculty' as well the weights of the sub factors follow similar trends in both AHP and FAHP methods. From Figure 5 one can easily see the importance of 'teacher/student ratio' is highest though numerically the AHP weight is slightly higher than the corresponding FAHP weight with respect to all the sub factors.

Figure 5: Comparing between the sub factor weights under faculty



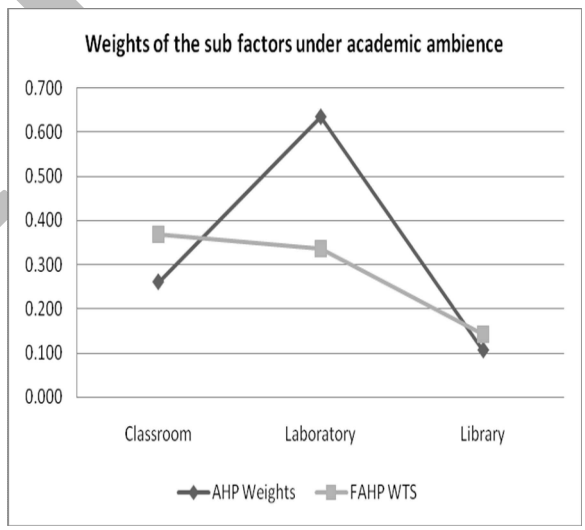
Under the factor 'student' there has been no change in trends except the sub factor 'placement' where the AHP and FAHP weights differ significantly. In both the AHP and FAHP models admission was considered most important among the other sub factors under 'student'.

Figure 6: Comparing between the sub factor weights under student



From Figure 7 one can see that there is some amount of variation in sub factor weights under 'academic ambience'. Though both the AHP and FAHP weights of 'library' is less than the other counterparts, but the importance in the weights vary significantly for laboratory and to some extent for classroom.

Figure 7: Comparing between the sub factor weights under academic ambience



Under teaching learning process there has been a significant variation across the sub factor weights observed from Figure 8. Here apart from 'syllabus coverage', the other two sub factor weights varied in the fuzzy and non-fuzzy evaluations.

Figure 8: Comparing between the sub factor weights under teaching learning process

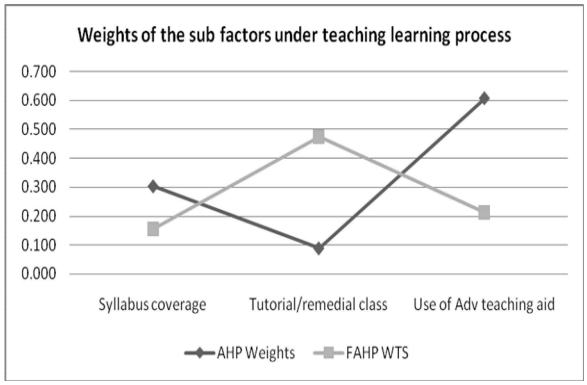
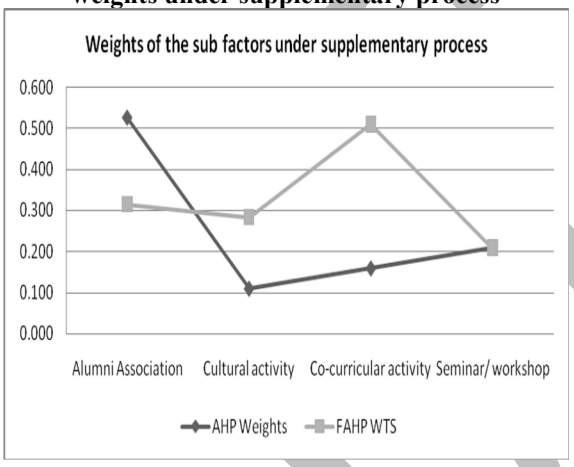


Figure 9 explains the comparisons of AHP and FAHP weights of the sub factors under 'supplementary process' where some trend can be seen except the sub factor 'seminar/workshop'. In all other three sub factors the respective model weights follow similar inclinations though there is a difference in the numerical value of the weights.

Figure 9: Comparing between the sub factor weights under supplementary process



From the above discussion it can be understood that within some factors there exists some level of variations in the fuzzy and non-fuzzy results. It generated interest in identifying whether there is a significant correlation between the global weights of the sub factors or not. Looking at the global weights of the sub factors with respect to AHP and FAHP methods one can observe a high correlation between the fuzzy and non-fuzzy weights (Pearson correlation = 0.880). Table 4 exhibits the SPSS output of the correlation between the AHP sub factor weights and FAHP sub factor weights in which it can be seen further that the correlation is significant at even 99% level ($\alpha = 0.000$).

Table 4: Correlation between the sub factor weights

		AHP weight subfactors	FAHP weight subfactors
AHP weight subfactors	Pearson Correlation	1	.880**
	Sig. (2-tailed)		.000
	N	20	20
FAHP weight subfactors	Pearson Correlation	.880**	1
	Sig. (2-tailed)	.000	
	N	20	20
**. Correlation is significant at the 0.01 level (2-tailed).			

C. Comparison between fuzzy and non-fuzzy alternative scores

After the AHP and FAHP weights of the factors and sub factors are compared, it is important to compare the alternative scores with respect to the fuzzy and non-fuzzy analytical hierarchy process.

From the comparison of the AHP and FAHP scores of the alternative 1, we can see from Figure 10 that there are small variations of scores across the sub factors. However it is difficult to comment on the significance of variations based on this figure only. It is thus important to see whether the correlation is significantly high or not. The SPSS output in Table 5 demonstrate that there is a significant correlation between the fuzzy AHP and AHP scores of ALT1 with $\alpha = 0.022$. Though the value of the Pearson correlation coefficient is only 0.508, but this value is significant at 95% level of confidence with 20 set of observations corresponding to the sub factors there in. From the fuzzy and non-fuzzy pair wise comparison scores of ALT2 in Figure 11 it can be seen that except 'teacher student ratio' the scores corresponding to the other sub factors are quite similar. However from the smaller variations it can be found that the AHP and FAHP scores are slightly different w.r.t the sub factors 'admission' and 'laboratory'. Interestingly like the previous alternative it is also difficult to comment on the significance of the variation of difference of the AHP and FAHP scores of ALT2from Figure 11. The SPSS output in Table 6 shows a significant correlation between the scores of the classical AHP and FAHP technique at even 99% level of confidence. The Pearson correlation coefficient is also in the higher side with a value of 0.724 at $\alpha = 0.000$.

Figure 10: Comparisonbetween the AHP and FAHP scores of ALT1

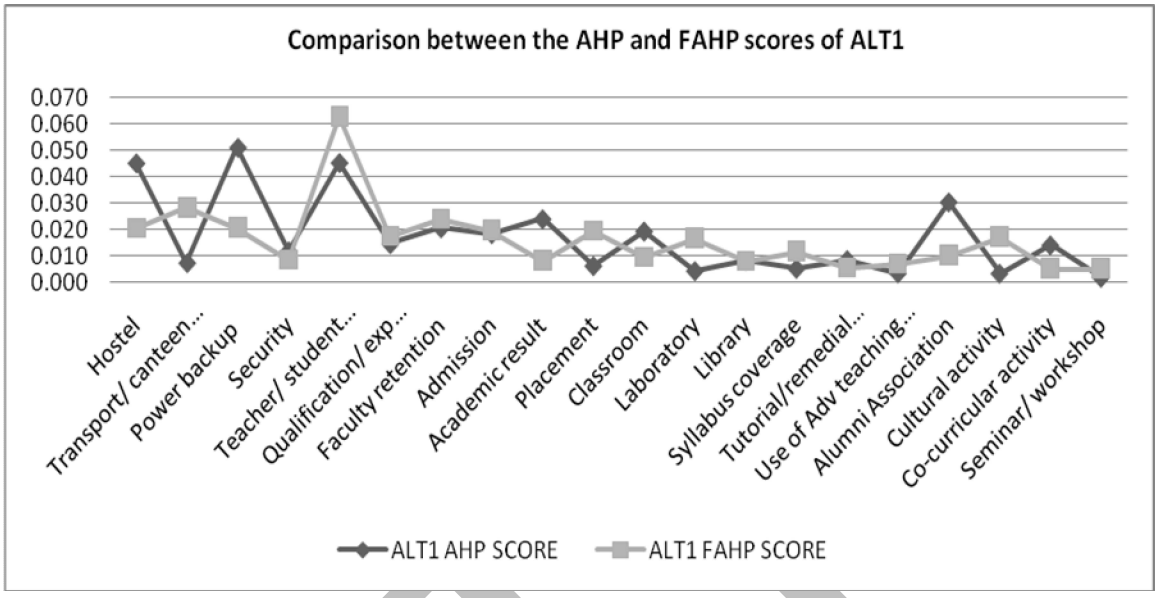


Table 5: Correlation between the AHP and FAHP scores of ALT1

		AHP score ALT1	FAHP score ALT1
AHP score ALT1	Pearson Correlation	1	.508*
	Sig. (2-tailed)		.022
	N	20	20
FAHP score ALT1	Pearson Correlation	.508*	1
	Sig. (2-tailed)	.022	
	N	20	20
*. Correlation is significant at the 0.05 level (2-tailed).			

Figure 11: Comparison between the AHP and FAHP scores of ALT2

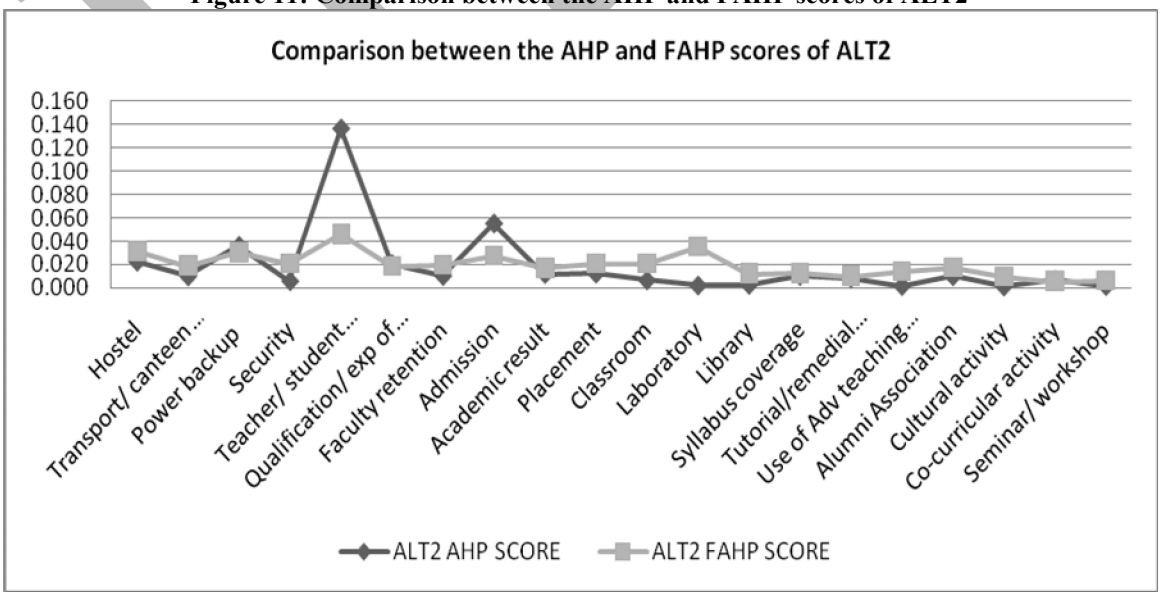


Table 6: Correlation between the AHP and FAHP scores of ALT2

		AHP score ALT2	FAHP score ALT2
AHP score ALT2	Pearson Correlation	1	.724**
	Sig. (2-tailed)		.000
	N	20	20
FAHP score ALT2	Pearson Correlation	.724**	1
	Sig. (2-tailed)	.000	
	N	20	20
**. Correlation is significant at the 0.01 level (2-tailed).			

Interestingly like the previous alternative it is also difficult to comment on the significance of the variation of difference of the AHP and FAHP scores of ALT2from Figure 11. The SPSS output in Table 6 shows a significant correlation between the scores of the classical AHP and FAHP technique at even 99% level of confidence. The Pearson correlation coefficient is also in the higher side with a value of 0.724 at $\alpha = 0.000$.

From the AHP and FAHP scores of ALT3 in Figure 12 one can see that there is some amount of variation with respect to the sub factors like 'admission', 'teacher student ratio' and 'laboratory'. Apart from these three sub factors the variations of results are not that prominent in other sub factors.
Nonetheless this figure is not capable of putting any light on the similarity or dissimilarity of the fuzzy and non-fuzzy weights of ALT3 and its statistical significance.

From the SPSS output in Table 7 one can see a significant correlation between the fuzzy and non-fuzzy scores of ALT3. Though the Pearson correlation coefficient is 0.582 which is not that high but is statistically significant at 99% level of confidence ($\alpha - 0.007$).

Comparing the aggregate alternativescores obtained from the AHP and FAHP models we can see that there is no change in the positions of the alternatives. In fact the order of importance of the alternatives is exactly the same in the two methods. Although the fractional difference of the alternative scores can be seen from Figure 13 but the Pearson correlation coefficient is as high as 0.95, which justifies that there exists almost no difference between the final AHP and the FAHP scores of the alternatives.

IV. Conclusion

Though a number of researchers talked about fuzzy analytical hierarchy process and its application in different fields of study, there is no empirical evidence in the earlier literature that agrees with the fact that FAHP provides better results than the classical AHP.

In this present study an attempt has been made to capture the difference in results obtained by using AHP and FAHP models respectively on the evaluation of private self-financed technical institutions in India. The result of this comparative study shows that there exists some differences in weights generated through non-fuzzy and fuzzy processes corresponding to some individual sub factors, but in case of the weights corresponding to the factors and sub factors in aggregate there is hardly any difference. Moreover the overall scores of the alternatives also indicate convergence with respect to the non-fuzzy and fuzzy evaluations.
Furthermore this study provides empirical evidence on the convergence of the results of AHP and FAHP methods in factor weight generations as well as alternative score generations. This can be seen from the SPSS outputs corresponding to the comparative studies. The point to be noted here is that careful and consistent pairwise comparisons can result in equally good outcomes irrespective of whether fuzzy mathematics is embedded with AHP or not.

Table 7: Correlation between the AHP and FAHP scores of ALT3

		AHP score ALT3	FAHP score ALT3
AHP score ALT3	Pearson Correlation	1	.582**
	Sig. (2-tailed)		.007
	N	20	20
FAHP score ALT3	Pearson Correlation	.582**	1
	Sig. (2-tailed)	.007	
	N	20	20
**. Correlation is significant at the 0.01 level (2-tailed).			

Figure 13: Comparison between the AHP and FAHP overall scores of the alternatives

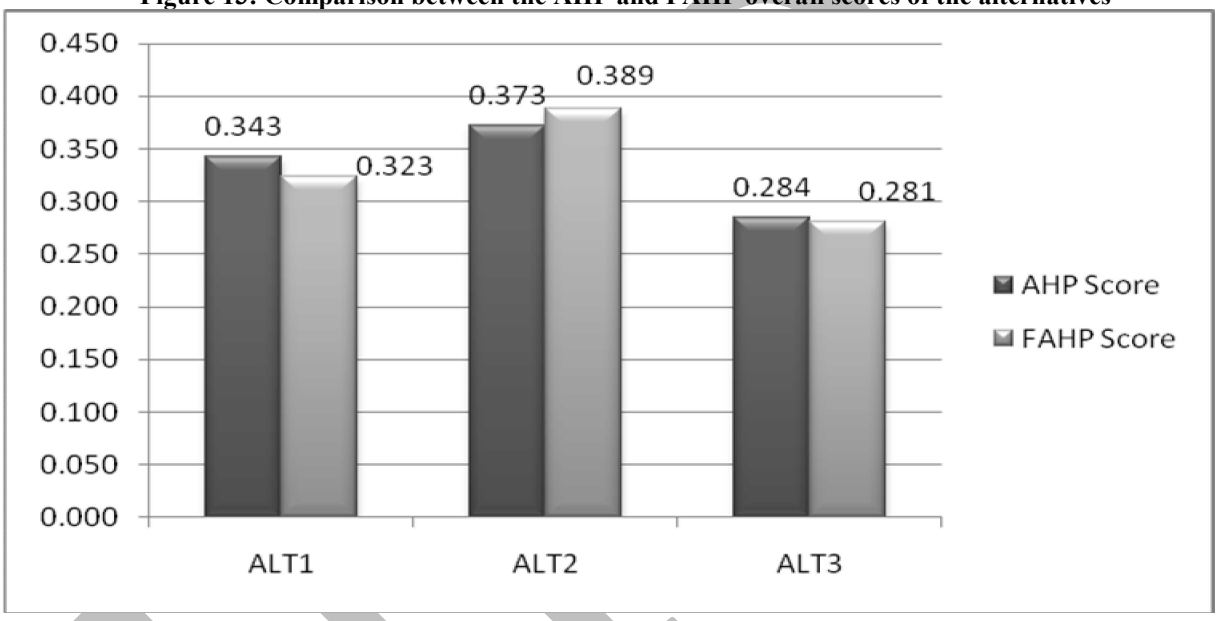
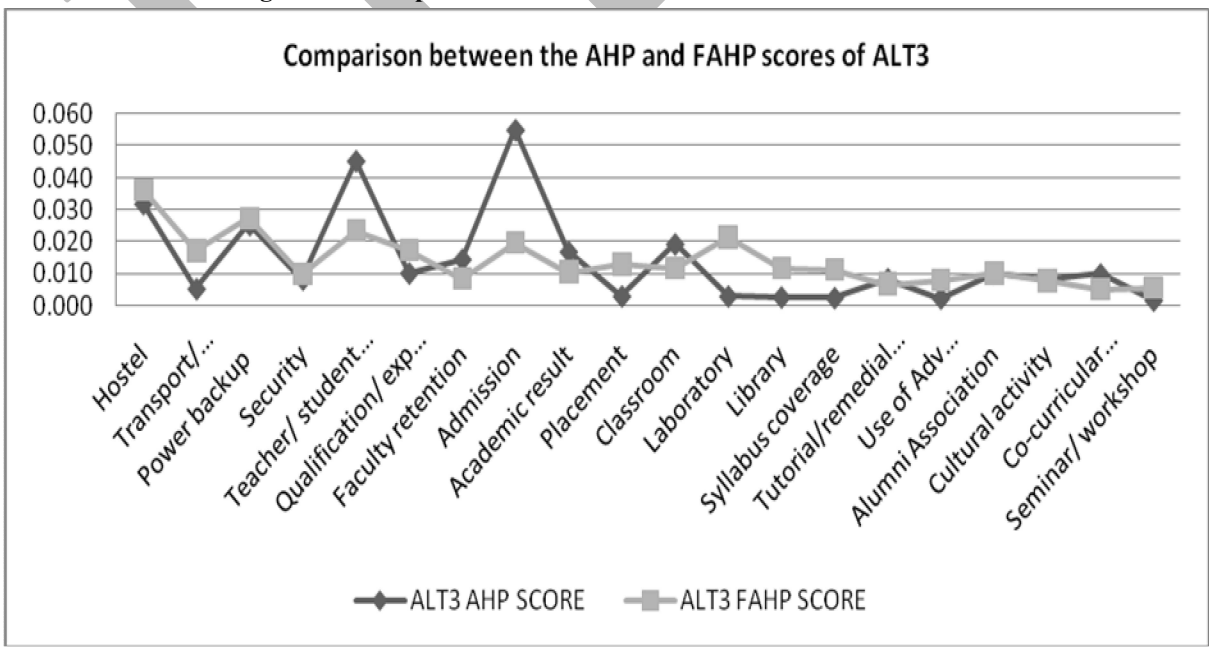


Figure 12: Comparison between the AHP and FAHP scores of ALT3



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